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Incorporating climate change into environmental impact assessment: perspectives from urban development projects in South Korea

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Abstract

Environmental Impact Assessment (EIA) has been a significant development in environmental management since the 1970s; however, climate change has only recently emerged as a topic of interest. This paper analyses the status of EIA of urban development projects in Korea one year after the implementation of the greenhouse gas emissions assessment regulation for EIA. It summarises the regulatory basis for EIA and the relevant guidance documents. Based on a review of EIA reports, types and boundaries, the expected challenges of incorporating climate change into EIA are identified. Also, this article recommends the next steps that may improve future EIA practice.

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Keywords: climate change; environmental impact assessment; greenhouse gas emissions assessment; Korea; urban development

1. Introduction

Climate change is one of the key challenges facing the world today; however, there is a gap between awareness and implementation of urban development practices to address climate change and it is still perceived as a distant phenomenon by planners [1-2]. Against this background, there is an emerging interest within the EIA community to use EIA as a tool to support decisions either to adapt to or mitigate climate change [3-8]. More specifically, with regards to EIA's role and contribution to incorporating Sustainable Development (SD) into urban planning, Alberti and Susskind [9] advocate that together with

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cumulative impact assessment, EIA is a crucial tool for setting and achieving SD targets against climate change.

A framework for considering climate change issues at each stage of the EIA process was devised by the Canadian Global Change Program in 2002 [6]. Such efforts have been reinforced by assessment practitioners and researchers, exploring uncertainty within assessment [2] and providing suggestions for possible indicators and sources of information [4-5]. More recently the Organisation for Economic Cooperation and Development (OECD) has endorsed the importance of incorporating climate change issues in EIA, calling on member states to include climate change considerations in their EIA guidelines [3].

This paper explores greenhouse gas (GHG) emissions assessment of urban development projects as part of the EIA process in Korea. Beginning with a brief history of the Korean EIA system, the paper then describes regulations and guidance on EIA incorporating climate change considerations. In the next section, eight recent EIA reports for urban development projects are reviewed to determine how they address climate change by exploring temporal and spatial boundaries and specific assessment methods used. Based on these results from the EIA report reviews, recommendations to improve EIA practice are presented.

1.1. Brief history of EIA in Korea

Since the Korean War ended in 1953, Korea has experienced some of the fastest economic and population growth in the world. However, this rapid growth has been inevitably accompanied with the accelerating use of land and resources for development. Under these circumstances, Korea's EIA system has been the core decision-support framework used to support the national goal for SD [10].

The evolution of EIA practice in Korea can be divided into four stages according to the major legislative milestones, namely: establishment, development, expansion, and enhancement (see Figure 1).

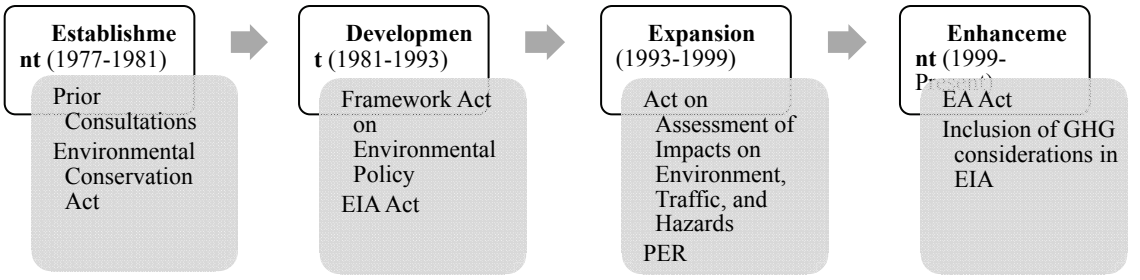

Fig. 1. Evolution of Korean EIA regulations

A form of partial EIA, called Prior Consultations, was first established in 1977 under the Environmental Conservation Act and it mandated environmental consultation on new development projects [11]. The requirement for more comprehensive EIA came into force in 1981 when the Framework Act on Environmental Policy was adopted, which required the preparation of EIA reports for certain projects [11]. In 1993, EIA acquired greater significance with the introduction of the Environmental Impact Assessment Act and Enforcement of Decree of the EIA Act, which facilitated enforcement of the EIA Act [11]. Wood [12] concludes that such independent and specific EIA legal provisions have advantages, such as permanence and evidence of commitment, avoidance of uncertainty, provision of a firm basis for public participation, and enforcement of EIA.

In 1999, a new *Act on Assessment of Impacts of on Environment, Traffic, and Hazards* was adopted, broadening the assessment criteria and the types of projects covered [13]. At that time, in order to address the potential limitations of the project-oriented EIA system, *Prior Environmental Review (PER)* − an Strategic Environmental Assessment-type process of evaluating the potential environmental impacts of administrative plans and major projects at an early stage, was legislated under the *Framework on Environmental Policy Act* [14].

Over the 30 years since the introduction of the *Prior Consultations*, EIA has served as an effective process for protecting the environment and adjusting the relationships between human beings and nature [15]. Nevertheless, there have also been challenges. For instance, EIA overlapped with other assessments within the *Act on Assessment of Impacts on Environment, Traffic, and Hazards*, since each had different administrative agencies [16]. The linkages between PER and EIA were also weak, resulting in ineffectiveness [13]. These challenges have stimulated the most recent regulatory revisions in 2009. The *Act on Assessment of Impacts on Environment, Traffic, and Hazards* has been reformed and renamed the *Environmental Assessment Act*. In the new law, the scope of EIA has become broader through the inclusion of GHG considerations and assessment requirements for impacts on traffic, disaster and demography have been removed [16].

1.2. Regulations and guidance on EIA incorporating climate change considerations

On 7 December 2009, the Korean Ministry of Environment (ME) published its first guideline for GHG emissions assessment to create awareness about climate change mitigation [7]. It sets forth the overall direction of the GHG emissions assessment and establishes a link with SD as the overall objective. On 31 January 2011, the guideline (hereafter referred to as *ME Guide*) was amended to provide more substantial assistance to assessment practitioners to include fuller consideration of climate change mitigation and offset of GHG emissions.

The *ME Guide* promotes the following principles [8]:

- Proponents, who are responsible for the assessment of GHG emissions, need to estimate GHG emissions from the proposed project and suitable measures to minimise the emissions should be pursued actively.
- Assessment of GHG emissions associated with project implementation, reduction targets and the effect of each reduction measure should be presented as quantitatively as possible.
- The methodology for calculating emissions, citations, references, etc., should be presented clearly.

The principles can be applied to development projects, such as energy infrastructure, urban development, industrial parks, transport and tourism. The inclusion of GHG emissions assessment within EIA reports is not a legal requirement, but the need for its inclusion can be decided by the EIA scoping committee depending on the nature of development, its size and strategic significance [8]. If the assessment is deemed unnecessary, it must be justified in writing by the committee.

The recommended contents of the assessment include: a site survey, estimation on the GHG emissions from the project and GHG reduction targets, and measures [8]. According to the *ME Guide*, emphasis should be placed on the initial survey on the development site, since it provides not only a list of GHG emission sources and sinks associated with the project, but also highlights the project's ability to meet the local or regional governments' climate change strategies. This shows that the guidelines acknowledge the importance of link between the strategic level (policies, plans and programmes) and the operational level (individual projects) [17-18].

A standardised approach for the collection and calculation of emission factors and sinks is provided by the *ME Guide*. In order to estimate emissions from a project, sources are divided into four groups: Energy; Agriculture, Forestry and Other Land Uses (AFOLU); Waste; and Building Materials. Then by

using the Intergovernmental Panel on Climate Change (IPCC) carbon emission factors [19] and the Korean Environment Corporation's *Guidelines for Regional GHG Gas Inventories* [20], the emissions from each source must be measured in terms of carbon dioxide, methane and nitrous oxide.

2. Status of EIA implementation of urban development projects in Korea

Since 2005, all Korean EIAs and their consultation records are databased in the EIA Support System (EIASS) [21]. Between January 2010 and February 2011, 26 EIA reports of urban development projects were submitted. In order to identify urban development projects that considered climate change as part of their EIA, a structured search of the EIASS website was conducted for the terms "climate change", "greenhouse", "GHG", "carbon", "CO_2", "emissions" and "energy". Table 1 lists projects (coded from C-1 to C-8) containing any of the listed terms in their EIA reports.

All the projects identified had substantial financial support either from the government or public-funding agencies and the projects also had well defined sustainability goals. For example, both housing for the elderly (C-3) and affordable housing projects (C-4, C-5, C-6, C-7 and C-8) are aimed at low-income and vulnerable groups and social equity, while the low carbon town project (C-1) is focused on reducing carbon emissions in response to climate change. Project C-2 was initiated as part of the government's *Open-market Innovation Program* and its objectives include revitalising market towns, retaining and strengthening services and creating more sustainable communities.

2.1. Assessment boundaries

A key consideration in EIA implementation is setting the temporal and spatial boundaries [22]. A lack of systematic approaches in boundary setting is particularly problematic when dealing with dynamic environmental issues and a more conceptualised way is needed [18]; however, this is particularly complicated when involving climate change.

2.1.1. Temporal boundaries

For instance, in reference to setting a temporal boundary by using historical data, Murtishaw *et al.* [22] cite examples of electricity grids in India, South Africa, Guatemala, and the USA to demonstrate that four possible trends for setting a GHG performance standard should be acknowledged, namely: stable emissions rates; steady trend; scattered GHG emissions rates; and clear break point. Their findings explain that too distant a temporal horizon can leave out the references to technology and fuel shifts, while setting severely time-limited boundaries will make an assessment less reliable as it may be obscured by sporadic fluctuations in emissions rates.

While estimating future emission rates by using historical data from reference projects is important, such projections should have a fixed future time limit, such as the operational lifetime of a project, the time of decommissioning, or a determined assessment period. As climate change is a long-term challenge, the relevant assessments may have to take into account a longer time period in comparison to conventional EIA practice. Surprisingly, however, there is no satisfactory discussion in the literature on the need for a broadened time scale.

In the selected case studies, the temporal boundaries set for the assessment are all from the start to the completion of construction. This indicates that temporal boundaries for the assessments were routinely selected based on the norms of behaviour and not the guidance. For example, none of the case study EIA reports address the complexity of temporal boundary settings. Additionally, there are no considerations

of possible sporadic changes in GHG emission levels or the potential sensitivity of timelines for the assessment.

2.1.2. Spatial boundaries

A recent International Energy Agency (IEA) report concluded that over 60% of the global energy use and an even larger share of fossil fuel related GHG emissions are emitted from urban sources and both energy usage and transportation are the main contributors [23]. While urban design aiming at greater densities, mixed uses and transit-oriented development contribute to emissions reduction, Weisz and Steinberger [24] argue that socio-cultural factors, such as life style and income, are responsible for emission increases.

Both physical factors and anthropogenic features need to be considered when setting spatial boundaries. Physical factors may include both climatic aspects, such as GHG emissions, temperature records, geological factors that are natural assets considered in conventional EIAs, and built environment such as buildings and infrastructures. Anthropogenic features may include transportation usage, consumption patterns and household incomes.

From the perspectives of emission sources, three emissions sources can be differentiated: Scope 1 includes all direct emissions, Scope 2 includes indirect emissions from electricity, and Scope 3 includes emissions from all other indirect emission sources [19]. In order to embrace all these direct and indirect emissions, as well as those associated factors for spatial boundary setting, assessors should extend its spatial boundaries in accordance with those described previously.

Except for project C-4, all of the case study projects used the development site physical boundary as the spatial boundary for assessment. Additionally, there was no acknowledgement of whether the development projects should include adjacent areas associated with the project for the climate change assessment scope. The comparisons of boundaries of each assessment are shown in Table 1.

Table 1. Lists of EIAs addressing climate change

	Projects	Types	Assessment boundaries					
			Temporal			Spatial		
			Years	T1	T2	Geographical boundaries	S1	S2
C-1	Sosa-Pyeongtaek	New settlement	2006-2011	No	No	Development site	No	Yes
C-2	Garak Market	Urban regeneration	2010-2018	No	No	Development site	No	Yes
C-3	Buyeo	New settlement	2010-2012	No	No	Development site	No	Yes
C-4	Gwangmeong-Siheung	New settlement	2010-2017	No	No	Development site and 3 surrounding districts	Yes	Yes
C-5	Hanam-Gamil	New settlement	2010-2015	No	No	Development site	No	Yes
C-6	Hangdong-Seoul	New settlement	2010-2016	No	No	Development site	No	Yes
C-7	Guwol-Incheon	New settlement	2010-2015	No	No	Development site	No	Yes
C-8	Guri-Galmae	New settlement	2010-2014	No	No	Development site	No	No

Notes:
T1: Does EIA indicate the complexity of temporal boundary settings for assessment incorporating climate change?
T2: Does EIA set appropriate temporal boundaries to overcome sporadic changes while including information on changes regarding the context-sensitivity?
S1: Does EIA set appropriate spatial boundaries to track both direct and indirect GHG emissions from development site and a nearby site associated with the proposed development activities?

S2: Does EIA set suitable spatial boundaries to cover not only the physical (climate or geological changes), but also anthropogenic factors such as fossil fuel combustion, and car exhaust etc.?

2.2. Assessment methods

With regards to the GHG inventory, all the projects used a similar numerical analysis. As introduced in the *ME Guide*, emissions from energy consumed for transport, heat and electricity were estimated per day per family unit with reference to the base year of 2008; however, embodied energy in building materials, waste and AFOLU were excluded. Furthermore, the implications of the estimated total emissions, such as the potential reductions against the business-as-usual practice, were not analyzed in the reports. Possible mitigation measures regarding the estimated emissions were introduced, but it was not in manner of ranking, weighting or scoring.

Exceptionally, project C-4 recognised that air pollution, such as ozone produced by photochemical reactions, can be sensitive to temperature and an iterative analysis was performed by evaluating the effect of a temperature increase scenario on air quality, using modelling simulations. The results showed that there was no significant association between the predicted climate change and local ozone fluctuations.

2.3. Acknowledgement of assessment linkages

To enhance assessment credibility, it is important to understand related factors that may affect assessment results. In order to investigate energy use and GHG emissions associated with development density, numerical experiments were carried out by Norman *et al.* [26] and their findings concluded that low-density suburban development is more energy and GHG intensive by a factor of 2.0 - 2.5 than high-density urban core development on a per capita basis. This kind of information on the relationships between anthropogenic factors of GHG emissions and development patterns is highly valuable to assessors for estimating potential GHG emissions.

While GHG emissions cause climate change, mitigation measures may have linkages with climate change adaption [1, 4, 27]. For example, green space which is regarded as a crucial component of urban planning can reduce flood risk (adaptation), and promote carbon reduction (mitigation); whereas, building cooling (adaptation) may be associated with increased energy consumption (opposite of mitigation). Hence, to identify optimal alternatives against climate change, both mitigation and adaptation issues should jointly be considered.

Assessment in all case studies contained information on possible mitigation measures, but extensive comparisons between alternatives or evaluations of linkages between adaptation and mitigation were missing. The linkage between development pattern and the total amount of GHG emissions was not observed in any of the case studies.

3. Conclusions and Recommendations

This article reviews the current approaches to assessing urban development projects through Korean EIA, especially its approach to climate change. Based on the review, conclusions and some recommendations are made to suggest improvements to assessment in order to better incorporate climate change.

The requirements for GHG emissions assessment in EIA will potentially bring benefits to society in the longer term. Such practices encourage innovative design and advanced building products to deliver low carbon developments and meet SD goals. In Korea, the necessity of assessment incorporating climate change considerations for urban development at its project level has been well recognised by the

ME Guide; however, this is not yet being delivered appropriately through existing EIA practice. From the case studies analysed, there is little evidence that temporal and spatial boundaries are appropriately chosen to accommodate climate change.

Even though simple to implement, the standardised quantitative GHG assessment featured in this research can be associated with hidden bias and does not necessarily represent a true measure of climate change. Systematic assessment methods need to be facilitated by the development of substantial guidelines describing desired assessment principles with sufficient examples to support the annotation process rather than providing definitive guidance.

With the evidence that assessment methods used in all case studies were identical, it is essential that the practitioners' openness to new assessment methods and their willingness to implement new assessment techniques are encouraged. Notable progress has been made internationally toward improving assessment methods. For example, Duinker and Greig [28] demonstrate how to reduce the assessment uncertainty by using project-oriented scenarios in relation to environmental variables including climate change. Checklists are a well-established mechanism and widely used for EIA to help test requirements of how the assessments are met and how effectively EIA has been integrated in to the environmental considerations of the planning process. In respect to EIA incorporating climate change, ClimAdapt [5], a network of environmental organizations, has reviewed various checklist methods and has placed attention on the different aspects of the process. Sheppard [29] demonstrated a visual analysis of landscape in the context of climate change to improve communication among stakeholders.

Finally, in-depth discussion about public consultation regarding climate change considerations is beyond this research scope, but workshops or online discussion forums on climate change implications and project responses may help to facilitate further public interest and thus alleviate perception gaps. Also greater investigation is required on ways to incorporate future communities into project outcomes.

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